

held fast from 24 to 48 hours. No boats entered or left this port between the afternoon of the 18th and late at night of the 20th. The amount of ice in the harbor increased greatly during the latter part of the month, but a narrow channel was kept broken by the boats. Since the 20th the ice fields in the lake have been shifting with the winds, causing much inconvenience to navigation but not seriously interrupting it.—*C. H. Eshleman, Observer, Grand Haven.*

*Ohio.*—The month, as a whole, was somewhat colder than the average. There was considerably more than the usual amount of precipitation, which occurred largely in the form of snow. The snowfall was very heavy in the greater portion of the State. The warm weather and heavy rains of the last 3 days melted the snow and caused the rivers to rise rapidly, and at the close of the month all streams were approaching dangerous stages.—*M. W. Hayes, Section Director, Columbus.*

The ice on the Maumee River here ranged from 11 to 13 inches in thickness on the 7th, 12 to 16 inches on the 14th, 8.5 to 13.5 inches on the 21st, and 9 to 15 inches on the 28th, the heaviest average being about 14 inches on the 14th. All ice cutting of consequence was completed here before the beginning of February. The ice began to soften a little on the last 3 days of the month, but previous to the 26th, it remained in practically the same condition and changed but little in thickness.—*W. S. Currier, Local Forecaster, Toledo.*

The total snowfall at this station for the past month, 18.4 inches, is the greatest recorded in any February for the past 26 years except in 1893, when the total for the month was 22.1 inches. The total snowfall for the present winter thus far is 60.0 inches. This amount is far in excess of the same period of any winter at this station during the past 26 years. The record for total snowfall for the entire winter at Sandusky is 62.9 inches, this amount occurring during the winter of 1892-3.—*E. H. Nimmo, Local Forecaster, Sandusky.*

From February 17 to 26, the ice in the lake was solid in all directions beyond vision, but during the night of February 26-27, the ice field moved off shore, leaving the southern edge about 4 to 6 miles from shore. The snowfall to date for the present season is 76.2 inches, which is greater than any amount for any complete season during the past 24 years. The greatest previous amount for any season was 69.5 inches, in 1907-8.—*James Kenealy, Local Forecaster, Cleveland.*

*Pennsylvania.*—The normal snowfall for February is 10.8 inches. For the past month the fall was 23 inches. The greatest amount previously recorded for any February was 21.4 inches in 1894.—*G. R. Oberholzer, Local Forecaster, Erie.*

*New York.*—The amount of snowfall for the month was exceptionally large, and, in many instances, surpassed all known records. Only 5 out of 49 stations reported less than 20 inches of snowfall, while 13 reported more than 40 inches. At Adams Center the amount was 85 inches. The observer, Mr. A. E. Cooley, states that the snowfall for the 3 winter months, 244.5 inches, has not been equaled for many years and exceeds the average by about 65 per cent, and that for February by at least 75 per cent, while the average depth of snow was the greatest since 1879; the amount on the ground on the 15th was 44 inches. On the same date the depth at Blue Mountain Lake, Hamilton County, was given as 45 inches; at Nehasane, 50 inches; Old Forge, 42 inches; and Volusia, 47 inches. Mr. W. H. Lennon, the observer at Brockport, Monroe County, says that the snowfall for February was greater than for any other month in the last 10 years and greater than for any February since the beginning of his records. At both Buffalo and Rochester the snowfall of the current month was the greatest known. Remarkably heavy snow attended the storm which was central near New York on the 12th. The influence of this disturbance began on the 11th and continued until the 13th. The resulting snowfall amounted to 17 inches at Oswego, 18 at Adams Center, and 33 at Palermo. Dates of other heavy storms were the 3d, 9th, 17th, and the 27-28th. In the case of the last, the high temperature and heavy rainfall reduced the snow covering to a considerable extent and the streams rose rapidly. Flood stages were reached by those of the Lake region and much damage resulted, particularly along the Genesee River in and near Rochester.—*W. M. Wilson, Section Director, Ithaca.*

The month of February, 1910, has broken all records for snowfall for any corresponding month since 1885, when the unmelted snowfall began to be recorded, the amount for the month just closed being 43.7 inches. It caused considerable trouble to railroads and trolley lines, transportation being delayed from 3 to 6 hours each day during the greater part of the month. During the snowstorm of the 11th and 12th, 16.4 inches of snow fell and some of the railroads were completely blocked for from 3 to 5 days. The total precipitation for the month, 5.74 inches, was a record breaker for the month of February. The mean temperature was slightly below the normal with a minimum of  $-6^{\circ}$  on the 6th; yet no severe cold waves occurred, the month being uniformly cold. A sudden thaw occurred from the 26th to the end of the month, and with the heavy rainfall caused serious and damaging floods along the lake shore from Dunkirk eastward and along the Niagara River towns from Buffalo to Niagara Falls.—*D. Cuthbertson, Local Forecaster, Buffalo.*

Snowfall, 43 inches, greatest February record. Bulk deposited during two storms, 11-13th, and 17-18th.—*L. M. Dey, Local Forecaster, Rochester.*

At the end of February the ice in Cazenovia Lake was 16 inches thick and in Oneida Lake 18 inches thick. Ice is thicker in both lakes than last winter, and there is more snow on the lakes than in many years. Feb-

ruary snowfall twice that of any February in past 8 years.—*M. R. Sanford, Local Forecaster, Syracuse.*

*Vermont.*—The portion of Lake Champlain, known as "Broad Lake," became frozen over on February 11. The ice thickened rapidly and was in condition for cutting by the last of the month. The thaw caused water to flow over the ice, a depth of 9 inches being reported at the end of the month. On February 28 the ice was 11 inches thick. Operations have been held up, although some ice suitable for storage purposes has already been harvested.—*J. K. Hooper, Local Forecaster, Burlington.*

Following is an extract from the Oswego Times, Oswego, N. Y., February 28:

The roads in the country leading to the city are in an almost impassable condition as the result of the sudden thaw. There were pitch holes enough before the rain came, but now there are many more of them and they go in deeper. Heavy teaming is practically impossible, and it is even difficult to move heavy loads on the city streets. It is reported that along the Hall road the flats are covered with several feet of water and that the road is flooded for hundreds of feet. As a result of the sudden thaw all the creeks are running bank full, and a couple of more days will mean big floods in all the lowlands. The river has risen rapidly and at the present time there is a tremendous current running. Fortunately the Oswego is a decent, well-behaved river at all times and never rises above the docks within the city limits.

## TOPOGRAPHY AND DRAINAGE—WEST SHORE OF LAKE MICHIGAN.

H. B. HERSEY, Inspector.

Beginning at the southern end of Lake Michigan, the west shore is generally low until it passes into Wisconsin. It then increases in elevation as it extends northward until it forms the ridge of comparatively high land between Green Bay and Lake Michigan.

The area draining directly into Lake Michigan is small, being only a narrow strip of land parallel to the lake, averaging from 15 to 20 miles in width. It is drained by small streams generally running parallel to the lake shore for some distance and then turning eastward into the lake. The most important of these streams are the Chicago River, having its source near the Wisconsin line, and running south until it empties into the lake at Chicago,<sup>1</sup> and the Milwaukee River, which pursues a southerly course for about 100 miles and passes through the City of Milwaukee into the lake. For the last 35 miles of its course the Milwaukee River is only 2 to 4 miles distant from the lake, but is separated from it by a ridge having an elevation varying from 75 to 150 feet above the level of the lake. It has quite a regular fall throughout its course averaging little more than 5 feet to the mile, and a drainage area of about 840 square miles.

Continuing northward only two streams worthy of mention are crossed before reaching Green Bay. These are the Sheboygan and the Manitowoc.

The Sheboygan rises within 4 miles of the eastern shore of Lake Winnebago at an elevation of nearly 400 feet above Lake Michigan, and pursues a circuitous course to the eastward, emptying into Lake Michigan at Sheboygan. Its drainage area is about 380 square miles.

The Manitowoc rises in the range of hills about 3 miles east of Lake Winnebago, and at an altitude of about 360 feet above Lake Michigan. It winds irregularly among the hills in an easterly direction until it reaches Lake Michigan. It has a drainage area of approximately 500 square miles. During the first half of its course it has a comparatively flat gradient, averaging 2.7 feet per mile, but in the last 35 miles its fall is about 8.3 feet per mile.

All other streams in Wisconsin whose waters eventually reach Lake Michigan pass through Green Bay. The most important of these is the Fox River, which has a drainage area of nearly 6,500 square miles. Of this area about 6,000 square miles drain into Lake Winnebago, the largest lake wholly

<sup>1</sup>The course of the Chicago River has been changed artificially, so that it now flows through the Drainage Canal into the Illinois River instead of into Lake Michigan.

within the State. The remainder of the drainage area lies between Lake Winnebago and Green Bay.

The Fox River has its source at a point southeast of the center of the State, and flows in a westerly direction for about 20 miles until it reaches the town of Portage; here it turns north and then northeast, pursuing a circuitous northeasterly course until within a few miles west of the middle of Lake Winnebago, when it turns to the southeast and empties into the lake. Lake Winnebago is nearly 30 miles in length and its greatest width is about 10 miles. After passing through Lake Winnebago the Fox continues its northeasterly course for a distance of 35 miles where it empties into the southern end of Green Bay.

The upper Fox, as the part of the river above Lake Winnebago is known, is a sluggish winding stream having a fall of less than 0.5 of a foot per mile. It passes through several small lakes, and at Portage it runs within about a mile of the Wisconsin River, which flows in the opposite direction and empties into the Mississippi. No important branches run into the upper Fox until within a few miles of Lake Winnebago, where it is joined by the Wolf River from the north. Although this is considered as a branch of the upper Fox, it is really a much more important stream, having a discharge 3 times as great. Its source is in a region of small lakes about 25 miles south of the Michigan line, and about 1,000 feet above the level of Lake Michigan. It has a rapid fall for the first 80 miles of its course, averaging a little less than 10 feet per mile, but after passing Shawano its fall averages only about 0.5 of a foot to the mile, and its low banks allow the surrounding country to be flooded in high water, sometimes in heavy freshets to a distance of several miles. It is joined in its lower course by several tributaries from the West, the most important being the Embarrass, the Little Wolf, and the Waupaca rivers.

The lower Fox, as the river is called after leaving Lake Winnebago, follows a northeasterly course and empties into Green Bay. This stream, although short, is important, as it carries all the drainage of the Lake Winnebago region. It is quite rapid, having a fall of about 165 feet in its 35 miles. Its valley is narrow and it has no tributaries of importance. The eastern side of the valley is steep, rising abruptly from 100 to 200 feet along the eastern shore of Lake Winnebago, and continuing down to Green Bay, but the western slope is more gradual. A remarkable feature of this stream is its uniformity of flow due

to the steadying effect of Lake Winnebago, with its area of 200 square miles, forming a natural reservoir.

Leaving the Fox, and going north on the shores of Green Bay the first stream met is the Oconto, which rises in the small lakes of the plateau region of northeastern Wisconsin at an elevation of nearly 1,000 feet above the Lake Michigan level, and flows in a general southeasterly direction into Green Bay. Its drainage area is not more than 450 square miles.

The next river to the north is the Peshtigo. It rises in the highest part of northeastern Wisconsin at an altitude of nearly 1,100 feet above Lake Michigan. It flows in a southeasterly direction a distance of about 95 miles and discharges into Green Bay. Its valley is narrow, giving a drainage area of about 1,125 square miles, and it has no important tributaries.

The Menominee River is the next to the north. This is a stream of considerable importance, formed by the junction of Michigamme and the Brule, and locates the boundary line between Wisconsin and Michigan for 100 miles. The Michigamme rises in upper Michigan within 12 miles of Lake Superior and flows in a southerly direction until it meets the Brule. The Brule has its source in the high swampy plateau of northeastern Wisconsin, which abounds in small lakes, and from which the Wisconsin River flows to the southwest. The source of the Brule is about 1,000 feet above the level of Lake Michigan. It flows in an easterly direction until it meets the Michigamme, forming the Menominee, which pursues a southeasterly course and empties into Green Bay. It has numerous tributaries, some being of considerable importance. The total drainage area of this system is about 4,000 square miles.

The next river of importance to the northward is the Escanaba. This rises in the same region as the Michigamme branch of the Menominee, in the hills well up toward Lake Superior, and flows in a general southeasterly direction, emptying into the northwestern point of Green Bay. This has a somewhat rapid descent during the first half of its course, but a more gentle fall in the lower part. It drains an area of approximately 1,500 square miles.

Several smaller streams flow into the north end of Green Bay, including the Days, Rapid, Whitefish, and Sturgeon. Of these the Whitefish and Sturgeon are the largest, and have a combined drainage of approximately 1,000 square miles. They both rise in the hills about 20 miles south of Lake Superior, and flow almost due south into Green Bay.